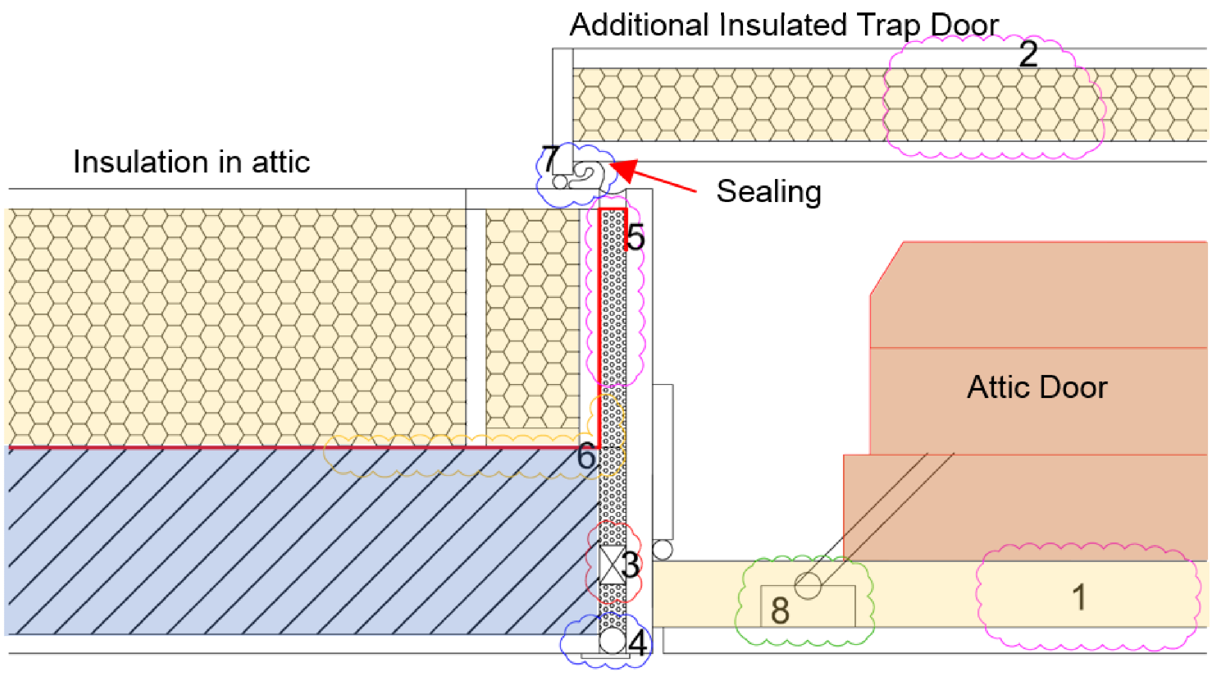
EuroPHit

# D5.1.2_Guidelines_Attic stairs




**INTELLIGENT ENERGY – EUROPE II**

Energy efficiency and renewable energy in buildings

IEE/12/070

**EuroPHit**

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]


Contract N°: SI2.645928

Co-funded by the Intelligent Energy Europe Programme of the European Union

**Technical References**

| | |
|---|---|
| Project Acronym | EuroPHit |
| Project Title | Improving the energy performance of step-by-step refurbishment and integration of renewable energies |
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| Project Duration | 1 April 2013 – 31 March 2016 (36 Months) |

| | |
|---|---|
| Deliverable No. | D5.1.2 |
| Dissemination Level | PU |
| Work Package | WP5_Product Development |
| Lead beneficiary | 05_iEPD |
| Contributing beneficiary(ies) | 01_PHI |
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| Date | 20.01.2015 |
| File Name | EuroPHit_D5.1.2b_AtticTrapDoors_PHI |

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# Abstract

This document elaborates on the final guidelines with precisely defined concepts for product development for attic stairs / loft hatches for the use in step-by-step, energy-efficient refurbishments of attic ceilings.

Passive House buildings provide optimal comfort with minimum energy costs and prove cost-effective over their life-cycles. In order to achieve such comfort and low life-cycle costs, the thermal quality of the components used in Passive Houses must meet stringent requirements. These requirements are directly derived from the hygiene and comfort criteria.

In contrast with the average operative indoor temperature, the minimum surface temperature may deviate by a maximum of 4.2K. A greater difference may lead to unpleasant cold air descent and perceptible radiant heat deprivation.

Attic stairs used to be a weak point of the thermal envelope. Availability of the required qualities, avoiding a high thermal bridge caused by the installation, and correct determination of the impact on the heating demand have been challenging details, which nevertheless need to be considered correctly. Therefore it was necessary to define criteria to fulfil the requirements of comfort, hygiene and energy efficiency.

# 1 Passive House suitable attic stairs

## 1.1 Requirements

The suitability of an attic staircase for a Passive House can be attested if the average thermal transmittance does not exceed $U_D \leq 1.00$ W/(m²K) for a test size of 0.70 m x 1.40 m. Separate calculation of the thermal transmittance of hatch and box-out is necessary for this.

The temperature factor should be $f_{Rsi=0.25\ m^2K/W} \geq 0.7$ everywhere.

The average thermal transmittance should be $U_{D,installed} \leq 1.10$ W/(m²K) in the installed state for cool-temperate-climates.

| Climate Zone | Hygiene criterion $f_{Rsi=0,25m^2K/W} >$ | Component U-value [W/(m²K)] | U-value installed [W/(m²K)] |
|---|---|---|---|
| 1 Arctic | 0.80 | 0.60 | 0.60 |
| 2 Cold | 0.75 | 0.80 | 0.80 |
| 3 Cool-temperate | 0.70 | 1.00 | 1.10 |
| 4 Warm-temperate | 0.65 | 1.20 | 1.20 |
| 5 Warm | 0.55 | 1.40 | 1.40 |
| 6 Hot | none | 1.40 | 1.40 |
| 7 Very hot | none | 1.20 | 1.20 |

**Figure 1 - Requirements for different climate zones**

The manufacturer must present an understandable concept or verification regarding airtightness of the installed components or better provide air tightness testing results according to standard regulations

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## 1.2 Calculation method

Calculation of the thermal characteristic values takes place in two separate steps in order to allow detailed calculation of the thermal transmittance of the panel (pnl) and the frame (f). This enables exact application in the project planning by the planner, also for dimensioning of attic staircases which do not correspond with the test size. A three-dimensional model with all selective penetrations is simulated for calculating the thermal transmittance of the panel.

The following applies (I):

$$U_{pnl} = \frac{Q_{pnl}}{A_{pnl} * \Delta_{\Theta}}$$

The overall model with the cover box is also simulated. The difference between the two heat flows leads to the determination of a frame parameter, hereafter called $U_f$.

The following applies (II):

$$U_f = \frac{(Q_{total} - U_{pnl} * A_{pnl} * \Delta_{\Theta})}{A_f * \Delta_{\Theta}}$$

The total thermal transmittance $U_D$ is obtained from the addition of the respective thermal transmittances taking into account the respective area percentage.

The following applies (III):

$$U_D = \frac{(A_{pnl} * U_{pnl} + A_f * U_f)}{A_D}$$

The requirements for the average thermal transmittance in the installed state are based on the requirements for thermal comfort. Besides a concept for an airtight connection, proof of suitability of the component must also be provided for installation situations.

For calculating the thermal transmittance in the installed state, it is necessary to determine the thermal transmittance using the length of the installation gap.

The following applies (IV):

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$$\chi_e = \frac{[Q - (A_{ges}.* U_{Decke} * \Delta_\Theta + A_D * U_D * \Delta_\Theta)]}{\Delta_\Theta}$$

The following applies (V):

$$\psi_e = \frac{\chi_e}{l_e}$$

### 1.2.1 Symbols, Units, Explanations

| Symbols | Unit | Explanation |
|---|---|---|
| $Q$ | [W] | Heat flow |
| $A$ | [m$^2$] | Reference area |
| $\Theta$ | [K] | Temperature |
| $\Delta_\Theta$ | [K] | Temperature difference |
| $U$ | [W/(m$^2$K)] | Thermal transmittance |
| X | [W/K] | Punctiform thermal bridge coefficient |
| $l$ | [m] | Reference length |
| $\psi$ | [W/(mK)] | Linear thermal bridge coefficient |
| $R_s$ | [(m$^2$K)/W] | Heat transfer resistance |
| $\lambda$ | [W/(mK)] | Thermal conductivity |

**Table 1 - Symbols, Units & Explanations**

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# 2 Design principles

The following design principles of attic stairs are considered as suitable for an energy efficient refurbishment of a ceiling serving as the thermal envelope. The design principles shown below make no claim of completeness. In order to fulfil the requirements in terms of hygiene, airtightness, energy efficiency and cost effectiveness, basic design principles have been developed to allow manufacturers using them as a guideline for component development. All design principles assume a thermal insulated ceiling.

## 2.1 New Attic Stairs

The replacement of an old attic stair throughout a new component requires a detailed planning implementation. The component itself needs to fulfil the requirements of comfort, corresponding with thermal transmittance under consideration of the installation and the geometrical and constructional thermal bridge effects.

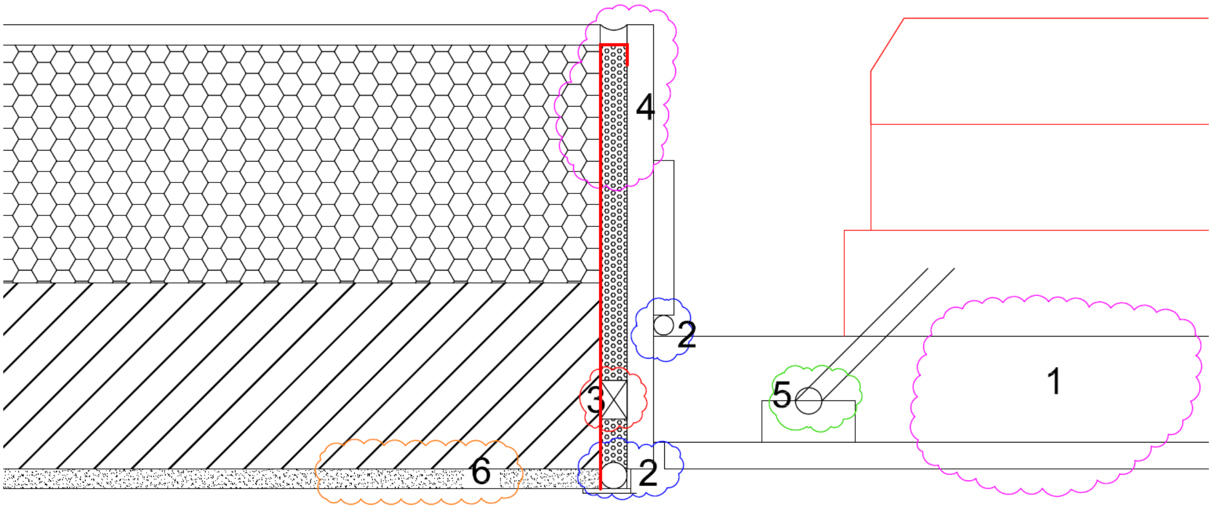


**Figure 2 - Design principle Attic Stairs**

1. Insulation of the hatch that leads to sufficient surface temperatures and low thermal transmission under the consideration of punctiform executions. An insulation thickness of 8 – 12 cm depending on the conductivity of the insulation material is recommended. In order to lower the installation thermal bridge caused by the geometrical offset it is recommended to install the hatch to the insulation layer of the ceiling as close as possible. If a plain installation to the ceiling closure is necessary, a broadening of the board should be taken into consideration.
2. Airtight sealing of the connection areas to prevent air leakages. The manufacturer provides airtightness-tests or at least a concept how to secure the absence of damages and a low infiltration rate.
3. Punctifom mountings to lower the impact of the thermal bridge and to enable installation gap insulation.

4. In order to lower the thermal bridge of the installation due to the geometrical offset it is necessary to improve the thermal resistance of the connection. A possibility to lower the thermal bridge could be using a filling insulating material.
5. Mechanics and other executions lead to an increased heat flow of the element up to 40%. Therefore it is necessary to plan these details carefully and to lower the impact by reducing the executions or using a spacer to lower the disturbance. A determination of the punctiform executions is recommended.
6. The interior plaster can serve as the airtightness layer. Therefore it is necessary to pay severe attention during the refurbishment. In addition to that, the connection points (2) require thorough realisation. Wooden beam ceilings require additional airtightness tape.

## 2.2 Improving existing situation with a trap door

A different approach for improving the thermal performance of the attic stairs is to improve the existing situation. The old attic stair remains and will be improved by a fully insulated trap door.

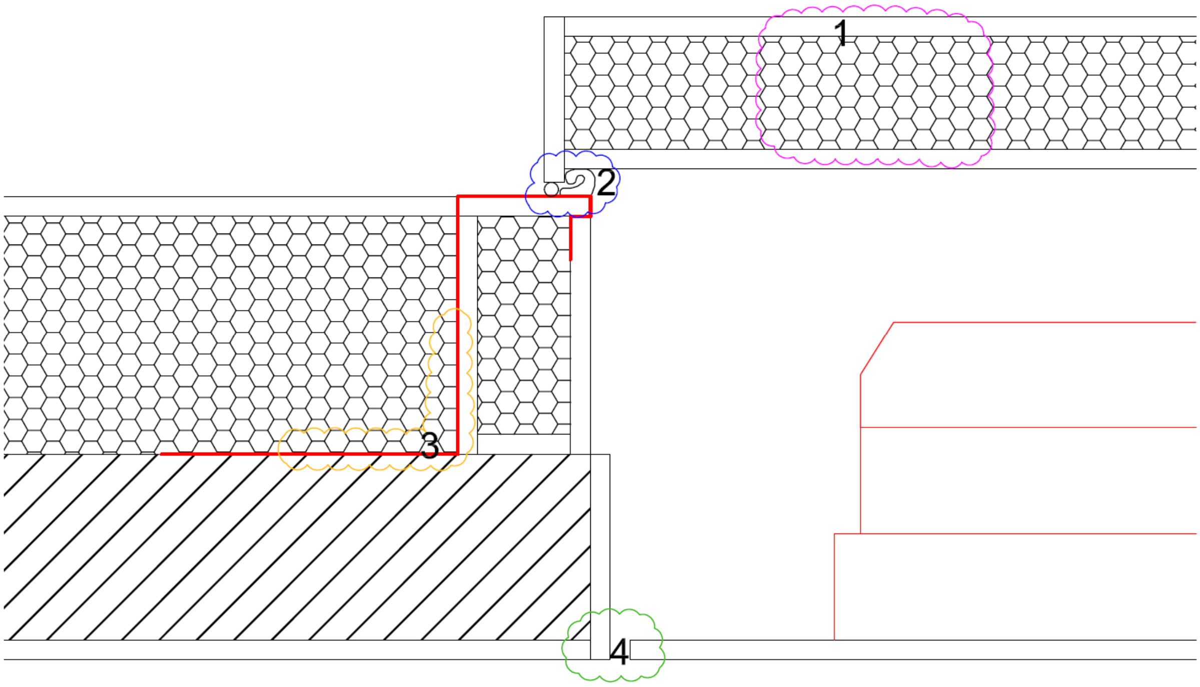


**Figure 3 – Design principle trap door**

1. The trap door needs to fulfil the requirements in terms of comfort and energy efficiency. An insulation thickness of minimum 8 cm is recommended. The mechanics and metal fittings can be mounted on a load bearing construction box, to make the thermal bridge effect of executions negligible.
2. In order to reduce leakages through the gap between ceiling and trap door, seals should be applied.

3. The manufacturer needs to provide a concept in order to fulfil the requirements of airtightness
4. The gap between ceiling and existing attic stairs should be narrowed or equipped with a sealing to lower the convective proportion of the transmission.

## 2.3 Combination of design principles

A third possible solution is to combine the design principles.

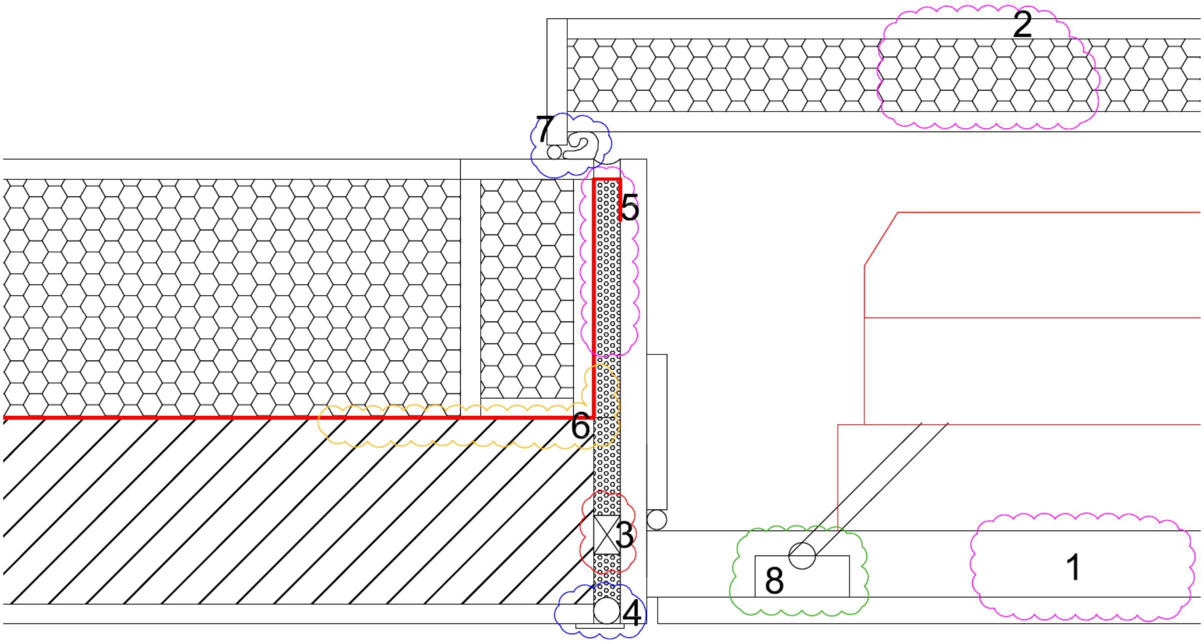


**Figure 4 - Combination of design principles**

1. Compared to single usage of components, the insulation thickness can be reduced, due to the two working insulation layers.
2. In order to reduce the geometrical thermal bridge effect of the installation, the trap door should still provide high thermal resistance.
3. Mechanics and other executions lead to an increased heat flow of the element up to 40%. Therefore it is necessary to plan these details carefully and to lower the impact by reducing the executions or using a spacer to lower the disturbance. A determination of the punctiform executions is recommended.
4. Airtight sealing of the connection areas to prevent air leakages. The manufacturer provides airtightness-tests or at least a concept how to secure the absence of damages and a low infiltration rate.
5. In order to lower the thermal bridge of the installation due to the geometrical offset it is necessary to improve the thermal resistance of the connection. The trap door reduces the geometrical effect, still a filling insulation material in the air gap is recommended.
6. This solution requires additional airtightness tape

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7. The gap between ceiling and trap door and ceiling and attic stairs should be narrowed or equipped with a sealing to lower the convective proportion of the transmission and to ensure the airtightness.
8. Reducing the thermal bridge effect caused by executions through mechanical fittings is recommended.